"Positive" Batteries

Advanced membranes produce longer lasting and safer batteries.

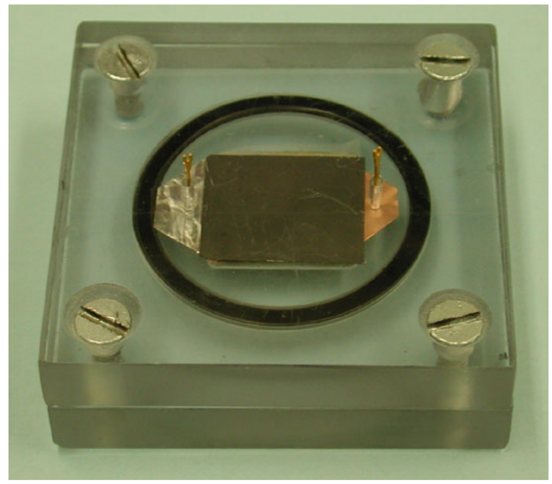
Lithium Battery Research at the INEEL

Rechargeable lithium batteries haven't really lived up to their expectations. They run down when they're not being used, they get old and stop taking charges, and they freeze if they get too cold. At the INEEL, chemists have significantly improved the heart of lithium rechargeable batteries. These new batteries function at very low temperatures (as low as outer space), have a much longer shelf-life, and are safer than conventional batteries.

At the Heart of the Matter

The centerpiece of INEEL's improved rechargeable battery is a solid battery electrolyte. Battery electrolytes provide ion transport and separate a battery's positive and negative electrodes. Currently available electrolytes for standard and rechargeable batteries are flammable, physically leaky, or electrically leaky.

For example, the liquid electrolytes in conventional lithium batteries are flammable, which is the reason they explode upon recharging. The liquid and gel electrolytes now used in rechargeable lithium batteries provide a "leaky" electrical barrier because these materials conduct electricity as well as ions. So the electrical charge leaks directly between the electrodes, and as the battery sits it loses charge. Also, these materials form insulating deposits that eventually destroy the battery. One-time-use lithium watch batteries use lithium metal as the power source. However, due to the limitations of conventional liquid electrolytes, they cannot be recharged without a real danger of fire or explosion. Our solid technology has promise to solve that problem, allowing lithium metal systems to be recharged over and over.



Prototype rechargeable lithium battery.

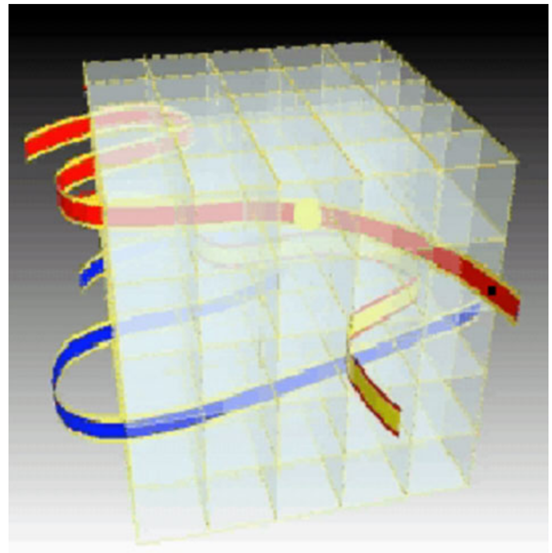
A Heart That Remains True

The solid electrolyte developed by INEEL chemist Mason Harrup and his colleagues is a unique mixture of a gel-like polymer ceramic – properly mixing the polymer and ceramic creates a clear membrane. Harrup and his team found that the composite membrane, originally investigated by Eastman-Kodak for anti-static applications, could be sandwiched between two electrodes and act as an electrolyte. The membrane easily conducts positive ions but not electrical current, providing effective electrical insulation with virtually no electrical leak. Harrup has kept prototype batteries on the shelf for a year without having to recharge them. In addition, the all-solid design resists damage, which allows a battery to be recharged again and again.

Continued on next page

Continued from front

This electrolyte also performs at temperature extremes where others don't. The membrane withstands high temperatures that degrade conventional electrolytes. And, unlike liquid or gel electrolytes that freeze, the solid continues to function down to -100 degrees Fahrenheit, making it useful for space exploration. Satellite companies and NASA have expressed an interest in its development. INEEL researchers are continuing to improve the voltage output of the solid lithium cells.



Lithium ion (yellow sphere) is transported through the stabilized composite electrolyte material, which is formed from ceramic scaffolding (cubes) and polymer (ribbons).

"Positive" Batteries

Management Contact:

Richard T. Jacobsen
(208) 526-4435
jacon@inel.gov

Technical Contact:

David L. Miller
(208) 526-9052
bsh@inel.gov

Mason Harrup
(208) 526-1356
harrmk@inel.gov